MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2320
Gaithersburg, Maryland 20899-2300

SRM Number: 3138
MSDS Number: 3138
SRM Name: Palladium Standard Solution

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Description: This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of palladium. One unit of SRM 3138 consists of five 10-mL sealed borosilicate glass ampoules of an acidified aqueous solution prepared gravimetrically to contain a known mass fraction of palladium. The solution contains hydrochloric acid at a volume fraction of approximately 10 %.

Material Name: Palladium Standard Solution

Other Designations:

Palladium: Pd; elemental palladium.
Palladium Chloride: Palladous chloride; palladium dichloride; palladium (II) chloride; dichloropalladium.
Hydrochloric Acid: Hydrogen chloride; muriatic acid; marine acid.

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

Component	CAS Registry	EC Number (EINECS)	Concentration (%)
Hydrochloric Acid	7647-01-0	231-595-7	10
Palladium Chloride	7647-10-1	231-596-2	1.7
Palladium	7440-05-3	231-115-6	1

EC Classification, R/S Phrases: Refer to Section 15, Regulatory Information.

3. HAZARDS IDENTIFICATION

NFPA Ratings (Scale 0-4): Health = 2 Fire = 0 Reactivity = 2

Major Health Hazards: Hydrochloric acid can cause severe or fatal burns if inhaled, swallowed, or absorbed through the skin. Palladium is relatively nontoxic, but some of its compounds (including palladium chloride) can cause severe illness if inhaled, swallowed, or absorbed through the skin. Exposure to palladium may also cause allergic sensitization.

Physical Hazards: None documented for this mixture; glass container may shatter. See Section 10.

Potential Health Effects

Inhalation: Inhalation of hydrochloric acid may cause death due to inflammation, spasm, and edema of the larynx and bronchi. Cyanosis, rapid breathing, chemical pneumonitis, and pulmonary edema may occur. Symptoms of exposure include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Inhalation of palladium chloride dust can cause severe irritation of the mucous membranes and upper respiratory tract. Water-soluble palladium compounds are more irritating than elemental Pd dust, but chronic exposure to Pd may damage the lungs or liver.

Skin Contact: Hydrochloric acid can cause severe burns, but it is not absorbed through the skin. Contact with palladium chloride can cause severe skin irritation and may be absorbed by this route, causing the effects described for ingestion. Palladium may cause skin irritation in persons who have become sensitized from previous exposures.

Eye Contact: Hydrochloric acid can cause severe burns and permanent eye damage. Palladium and its compounds can cause eye irritation with redness and pain. Water-soluble palladium compounds are more irritating than elemental Pd dust.

Ingestion: Hydrochloric acid can cause severe corrosive injury to the mucous membranes and GI tract. Internal bleeding may cause a drop in blood pressure. Other effects may include shock, metabolic acidosis, and circulatory collapse. Ingestion of palladium chloride may cause severe illness or death. Elemental Pd is less toxic because it is poorly absorbed by the body, but ingestion of a large dose may cause nausea, vomiting, and diarrhea.

Medical Conditions Aggravated by Exposure: The mixture and its three components may aggravate pre-existing disorders of the eyes, skin, respiratory tract, GI tract, or immune system (allergies).

Listed as a Carcinogen/ Potential Carcinogen:

	Yes	No
In the National Toxicology Program (NTP) Report on Carcinogens		X
In the International Agency for Research on Cancer (IARC) Monographs		X
By the Occupational Safety and Health Administration (OSHA)		X

Note: Palladium chloride has caused tumors in some animal studies.

4. FIRST AID MEASURES

Inhalation: Move the person to fresh air immediately. If not breathing, qualified personnel may start CPR or give oxygen if necessary. Get medical aid at once, and bring the container or label.

Skin Contact: Remove contaminated clothing and shoes. Flush affected skin with water for at least 15 minutes, then wash thoroughly with soap and water. If burns are severe or if skin irritation persists, get medical aid and bring the container or label. Wash contaminated clothing before reusing.

Eye Contact: Remove contact lenses (if any). Do not allow victim to rub eyes or keep eyes closed. Flush eyes with large amounts of running water for at least 30 minutes, keeping eyelids open and raising lids to remove all chemical. Get medical aid at once, and bring the container or label.

Ingestion: Contact a poison control center immediately for instructions. Wash out mouth with water, but do not induce vomiting. Get medical aid at once, and bring the container or label.

5. Fire Fighting Measures

Fire and Explosion Hazards: No data are available for this mixture, but it is not believed to be a significant fire or explosion hazard. The behavior of the solution may differ from that of the individual components. Hydrochloric acid does not burn, but it may release toxic, corrosive, flammable, or explosive gases, and may also react with water to produce heat. Hydrogen chloride gas is heavier than air and may accumulate in low areas. Palladium metal (not present in this mixture) may be listed as a pyrophoric metal for shipping purposes.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire: water spray, dry chemical, carbon dioxide, or foam. (These guidelines apply to the mixture; when the components are considered separately, different precautions may apply.)

Fire Fighting: Avoid inhalation of material or combustion byproducts. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA).

Flash Point (°C): N/A

Autoignition (°C): N/A

Lower Explosive Limit (LEL): N/A

Upper Explosive Limit (UEL): N/A

Flammability Class (OSHA): N/A

6. Accidental Release Measures

Occupational Release: Notify safety personnel of spills. Surfaces contaminated with this material should be covered with soda ash or sodium bicarbonate to neutralize the acid. Place the neutralized material into containers suitable for eventual disposal, reclamation, or destruction.

Disposal: Refer to Section 13, Disposal Considerations.

7. Handling and Storage

Storage: Store unopened containers of this material in a dry place at room temperature. Protect from physical damage, heat, and light, and isolate from incompatible materials. Use opened containers immediately or discard.

Safe Handling Precautions: Wear gloves and chemical safety goggles (Section 8). Engineering controls should maintain airborne concentrations below TLV (Section 8).

8. Exposure Controls and Personal Protection

Hydrochloric Acid:

ACGIH TLV-TWA: 5 ppm or 7.6 mg/m^3
OSHA TLV-TWA: 5 ppm or 7.6 mg/m^3

Palladium Chloride: No TLV has been established for this material. Limits for total dust, nuisance dust, or particulates not otherwise classified:

ACGIH TLV-TWA: 10 mg/m^3 (inhalable particles); 3 mg/m^3 (respirable particles)
OSHA TWA-PEL: 15 mg/m^3 (total dust); 5 mg/m^3 (respirable dust)

Palladium: No TLV has been established for this material. Limits for total dust, nuisance dust, or particulates not otherwise classified:

ACGIH TLV-TWA: 10 mg/m^3 (inhalable particles); 3 mg/m^3 (respirable particles)
OSHA TWA-PEL: 15 mg/m^3 (total dust); 5 mg/m^3 (respirable dust)

Ventilation: Use local or general exhaust to keep employee exposures below limits. Local exhaust ventilation is preferred because it can control contaminant emissions at the source, preventing dispersion into the general work area. Refer to the ACGIH document *Industrial Ventilation, a Manual of Recommended Practices*.

Respirator: If necessary, refer to the NIOSH document *Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* for selection and use of respirators certified by NIOSH.

Eye Protection: Use chemical safety goggles where dusting or splashing of solutions may occur. See OSHA standard (29 CFR 1910.133) or European Standard EN166. The employer should provide an emergency eye wash fountain and safety shower in the immediate work area.

Personal Protection: Wear appropriate gloves and protective clothing to prevent contact with skin.

9. PHYSICAL AND CHEMICAL PROPERTIES

Hydrochloric Acid	**Palladium Chloride**	**Palladium**
Appearance and Odor: Colorless liquid; pungent, irritating odor (may be undetectable at PEL).	**Appearance and Odor:** Dark red to brown deliquescent crystals	**Appearance and Odor:** Silver-white, ductile metal
Relative Molecular Weight: 36.46	**Relative Molecular Weight:** 177.3	**Relative Molecular Weight:** 106.4
Molecular Formula: HCl	**Molecular Formula:** $PdCl_2$	**Molecular Formula:** Pd
Specific Gravity: 1.05 (10%)	**Specific Gravity:** 4.0	**Specific Gravity:** 12.0
Solvent Solubility: Soluble in alcohol and benzene	**Solvent Solubility:** Soluble in hydrochloric acid, hydrobromic acid, ethanol, acetone, solutions of metal alkali chlorides	**Solvent Solubility:** Soluble in aqua regia, sulfuric acid, and fused alkali
Water Solubility: Soluble, with slight evolution of heat	**Water Solubility:** Soluble	**Water Solubility:** Insoluble
Boiling Point (°C): 53 (127°F)	**Boiling Point (°C):** N/A	**Boiling Point (°C):** 2963 (5365°F)
Melting Point (°C): -74 (-101°F)	**Melting Point (°C):** 679 (1254°F), decomposes	**Melting Point (°C):** 1555 (2831°F)
Vapor Pressure (kPa): 25 @25°C	**Vapor Pressure (Pa):** N/A	**Vapor Pressure (Pa):** Negligible
Vapor Density (Air=1): N/A	**Vapor Density (Air=1):** N/A	**Vapor Density (Air=1):** N/A
Critical Solution Temperature: N/A	**Critical Solution Temperature:** N/A	**Critical Solution Temperature:** N/A
pH: 1.0 (0.1M solution)	**pH:** N/A	**pH:** N/A

NOTE: The physical and chemical data provided are for the pure components. No physical or chemical data are available for this solution of palladium and hydrochloric acid. The actual behavior of the solution may differ from the individual components.

10. STABILITY AND REACTIVITY

Stability: __X__ Stable _____Unstable

Stable at normal temperatures and pressure.

Conditions to Avoid:

Incompatible Materials:

Hydrochloric Acid: Incompatible with cyanides, metals, hydroxides, amines, bases, metal cyanides, oxidizing materials, acids, halocarbons, combustible materials, halogens, and metal salts.

Palladium Chloride: Incompatible with organic solvents, ammonia, zinc, strong oxidizing agents, aluminum, magnesium, nitrates, and thiocyanates.

Palladium: Incompatible with arsenic, sulfur, other metals, ozone, sodium tetrahydroborate, combustible materials, acids, peroxides, oxidizing materials, and metal salts.

Fire/Explosion Information: See Section 5.

Hazardous Decomposition: Thermal decomposition of hydrochloric acid may release acid halides. Thermal decomposition of palladium chloride may release toxic chlorine gas and/or chloride dihydrate.

Hazardous Polymerization: _____ Will Occur __X__ Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: __X__ Inhalation __X__ Skin __X__ Ingestion

Hydrochloric Acid:

Human, inhalation: LC_{Lo} (30 min) = 1300 mg/kg
Human, inhalation: LC_{Lo} (5 min) = 3000 mg/kg
Rat, inhalation: LC_{Lo} (24 hrs) = 685 mg/m^3
Rat, oral: LD_{50} = 700 mg/kg (31.5% in water)

Palladium Chloride:

Rat, intratracheal: LD_{50} = 6 mg/kg
Rat, oral: LD_{50} = 2704 mg/kg
Mouse, intraperitoneal: LD_{50} = 153 mg/kg

Palladium: Acute toxicity data were found only for Pd compounds.

Target Organ(s): Skin, eyes, respiratory tract, GI tract, liver.

Mutagen/Teratogen: The reproductive effects of hydrochloric acid have not been fully investigated. Genetic toxicity tests of palladium salts have yielded negative results.

Health Effects: See Section 3.

12. ECOLOGICAL INFORMATION

Hydrochloric Acid: When released to water, HCl is ionized. Neutralization depends on the buffer capacity of the water. In the atmosphere, HCl is absorbed in cloud droplets and transformed to Cl-, with a half-life of 5.5 days. The solubility of HCl indicates a high mobility in soil. Ecotoxicity data:

Bluegill (*Lepomis macrochirus*): LC_{50} (96 hrs) = pH 3.5
Mosquitofish (*Gambusia affinis*): LC_{50} (96 hrs) = 282,000 µg/L
Common Shrimp (*Crangon crangon*): LC_{50} (48 hrs) = 260,000 µg/L

Palladium Chloride:

Freshwater fish (*Oryzias latipes*): LC_{Lo} (24 hrs) = 7 mg/L
Worm (*Tubifex tubifex*): LC_{50} (24 hrs) = 0.237 mg/L

Palladium:

Algae (*Scenedesmus subspicatus*): EC_{50} (24 hrs, reduced growth) = 0.03 mg/L
Algae (*Scenedesmus subspicatus*): EC_{50} (72 hrs, reduced biomass) = 0.02 mg/L
Rainbow trout (*Oncorhynchus mykiss*): LC_{50} (96 hrs) = 0.19 mg/L

Environmental Summary: This mixture and its components are toxic to aquatic organisms. Do not release to the environment.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: One or more components of this mixture is a RCRA hazardous waste. Dispose of container and unused contents in accordance with federal, state, and local requirements for acid waste, which vary according to location. Decontaminate containers before recycling. Processing, use, or contamination of this product may change the waste management options.

14. TRANSPORTATION INFORMATION

U.S. DOT and IATA: Hydrochloric Acid Solution, Hazard Class 8, UN1789, Packing Group II/III

15. REGULATORY INFORMATION

U.S. REGULATIONS

CERCLA Sections 102a/103 (40 CFR 302.4):

Hydrochloric Acid: RQ = 5000 lb.
Palladium Chloride: Not regulated
Palladium: Not regulated

SARA Title III Section 302: Not regulated

SARA Title III Section 304: Not regulated

SARA Title III Section 313: Not regulated.

OSHA Process Safety (29 CFR 1910.119): Hydrochloric acid (anhydrous) is regulated.

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE:	Yes
CHRONIC:	Yes
FIRE:	No
REACTIVE:	Yes
SUDDEN RELEASE:	No

STATE REGULATIONS

California Proposition 65: No components are regulated.

CANADIAN REGULATIONS

WHMIS Classification:

Hydrochloric Acid: C (oxidizing material), D1A (very toxic material), E (corrosive material)
Palladium Chloride: D2B (toxic material)
Palladium: D2B (toxic material)

WHMIS Ingredient Disclosure List: Hydrochloric acid and palladium (II) chloride are regulated.

CEPA Domestic Substances List (DSL): All three components are regulated.

EUROPEAN REGULATIONS

EU/EC Classification:

Hydrochloric Acid: T (Toxic), C (Corrosive)
Palladium Chloride: XN (Harmful); not classified in Annex I of Directive 67/548/EEC; not on a priority list.
Palladium: XN (Harmful); not classified in Annex I of Directive 67/548/EEC; not on a priority list.

Risk Phrases (mixture):

R23 (toxic by inhalation)
R25 (toxic if swallowed)
R34 (causes burns)
R36/37/38 (irritating to eyes, respiratory system and skin)
R43 (may cause sensitization by skin contact)

Safety Phrases (mixture):

S20/21 (when using, do not eat, drink or smoke)
S28 (wash after contact with skin)
S45 (in case of accident or illness, see doctor; show label)
S60 (dispose of this material and its container as hazardous waste)

NATIONAL INVENTORY STATUS

U.S. Inventory (TSCA): All three components are listed.

TSCA 12(b), Export Notification: No components are listed.

16. OTHER INFORMATION

Sources:

Hazardous Substances Data Bank (HSDB): Palladium, Elemental.

Hazardous Substances Data Bank (HSDB): Palladium (2+) Chloride.

Hazardous Substances Data Bank (HSDB): Palladium Compounds.

IUCLID Chemical Data Sheet: Hydrogen Chloride. European Chemicals Bureau, 19 February 2000.

U.S. National Institute for Occupational Safety and Health, *NIOSH Pocket Guide to Chemical Hazards*, June 1990 edition. DHHS (NIOSH) Publication No. 90-117.